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PATENT


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8-23-04

Date:

  
Himanshu S. Amin

OFFICIAL

## IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application of:

Applicant(s): Bharath Rangarajan, *et al.*

Examiner: Binh X. Tran

Serial No: 09/845,454

Art Unit: 1765

Filing Date: April 30, 2001

Title: SYSTEM AND METHOD FOR ACTIVE CONTROL OF ETCH PROCESS

Mail Stop Appeal Brief-Patents  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

## REPLY BRIEF

Dear Sir:

Applicants' representative submits this Reply Brief in response to the Examiner's Answer dated June 29, 2004. A credit card payment form is filed concurrently herewith in connection with all fees due regarding this document and the Request for Oral Hearing. In the event any additional fees may be due and/or are not covered by the credit card, the Commissioner is authorized to charge such fees to Deposit Account No. 50-1063 [AMDP662US].

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REMARKS

Claims 1-12 and 25 are currently pending in the subject application and are presently under consideration. Favorable reconsideration of the subject patent application is respectfully requested in view of the comments herein.

I. Rejection of Claim 1 under 35 U.S.C. §103(a)

Claim 1 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Eriguchi, *et al.* (U.S. 6,113,733) in view of Su (U.S. 6,486,492). Reconsideration and allowance of claim 1 is respectfully requested for at least the following reasons. The Examiner has failed to establish a *prima facie* case of obviousness.

To reject claims in an application under §103, an examiner must establish a *prima facie* case of obviousness. A *prima facie* case of obviousness is established by a showing of three basic criteria. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art and not based on applicant's disclosure. *In re Vaack*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

In particular, and as will be described in more detail below, neither Eriguchi, *et al.* nor Su teach or suggest *a system for directing a single beam of light onto one or more gratings* as recited in independent claim 1. Further, as the cited references do not teach or suggest the aforementioned claim elements, they cannot disclose, teach, or suggest *an etch monitoring system operable to measure one or more etching parameters from light reflected from the one or more gratings* as claimed. The present invention as recited in this claim directs a *single beam of light* upon *one or more gratings*, and thereafter utilizes the reflected light to *measure one or more etching parameters*. The light reflected from the *one or more gratings* is captured and employed to determine various parameters related to an etching process, including but not limited to size of features on a wafer, shape of features on a wafer, location of features on a wafer, chemical properties of a wafer, size of gratings, shape of gratings, location of gratings,

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size of space between features, shape of space between features, and location of space between features. While the aforementioned parameters that can be measured by utilizing the subject invention as recited in claim 1 are not claimed, they are provided to illustrate advantages of *measuring etching parameters from light reflected from the one or more gratings*.

Eriguchi, *et al.*, rather than *directing a single beam of light onto one or more gratings* as claimed, must simultaneously direct two beams of light to obtain information relating to a semiconductor region. In particular, Eriguchi, *et al.* teaches a system for detecting defects in a semi-conductor region *via* emitting two light beams - an exciting light and a monitoring light. A section in Eriguchi, *et al.* (col. 9, lines 41-52) describing this system is reproduced below.

An optical evaluation method according to the present invention is for evaluating processing performed with respect to a substrate having a semiconductor region in a chamber, the method comprising the steps of: supplying measurement light to the semiconductor region of the substrate in the chamber; intermittently supplying exciting light to the semiconductor region; and calculating a change rate of a reflectance of the measurement light by dividing a difference between the respective reflectances of the measurement light in the presence and absence of the exciting light supplied to the semiconductor region by the reflectance of the measurement light in the absence of the exciting light.

From this excerpt it is readily apparent that Eriguchi, *et al.* requires simultaneous use of two light beams to generate a change rate of reflectance, which can be utilized to determine number of defects in the semiconductor region, thickness of film in the semiconductor region, and depth of damaged layers in the semiconductor region. This requirement of simultaneous utilization of two light beams is in stark contrast to *directing a single beam of light onto one or more gratings* as claimed, and cannot enable the present invention as recited in the subject claim. In the Examiner's Answer it is asserted that noting a disparity in utilizing two beams and a single beam is not commensurate with the scope of the claims. When utilizing this reasoning, however, the Examiner is effectively giving no patentable weight to the term *single* in the subject claim. While the Examiner's contention may carry weight if no modifier existed prior to the element *beam of light* within the subject claim, in this instance such is not the case. Rather, the term

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single is employed to modify the element *beam of light*, and must be given weight when interpreting the subject claim.

Further, as stated above, Eriguchi, *et al.* fails to teach or suggest *measuring one or more etching parameters from light reflected from the one or more gratings* as claimed. In fact, the Examiner concedes that there is no mention of a *grating* at all in Eriguchi, *et al.* by stating, "the Examiner recognizes that Eriguchi does not explicitly use the term "grating" in the specification." The term grating is defined to mean "a system of close equidistant parallel lines or bars, especially lines ruled on a polished surface, used for producing spectra by diffraction." (See Webster's Revised Unabridged Dictionary, © 1996, 1998 MICRA, Inc., <http://dictionary.reference.com/search?q=grating>). Not only does Eriguchi, *et al.*, not specifically disclose use of a *grating* as defined above, but Eriguchi, *et al.* further does not teach or suggest directing light onto a grating as recited in this claim.

To establish a case of obviousness, the cited reference(s) *must provide a teaching, suggestion, or reason to substitute* [an element or limitation] ... in the prior art. The absence of such a suggestion to combine is dispositive in an obviousness determination. *Gambro Lundia AB v. Baxter Healthcare Corp.*, 110 F.3d 1573, 1579, 42 U.S.P.Q.2d 1378 (Fed. Cir. 1997).

Rather, Eriguchi, *et al.* discloses "supplying light to a semiconductor region," without teaching, suggesting, or disclosing that the semiconductor region is a *grating*. (See col. 9, lines 44-46). By *directing a single beam of light onto one or more gratings*, an etch monitoring system can *measure one or more etching parameters from light reflected from the one or more gratings*. Such measurement is obtained by collecting reflected light from the one or more gratings, wherein the reflected light creates spectra by diffraction. Such a feature is inherent, as light reflected from a grating will necessarily generate spectra *via* diffraction. Nowhere in Eriguchi, *et al.* is there a disclosure of a *grating*, a spectra created by diffraction, or any other teaching or suggestion of a *grating*.

Su, like Eriguchi, *et al.*, does not disclose, teach, or suggest *directing a single beam of light onto one or more gratings* and *measuring one or more etching parameters from light reflected from the one or more gratings*. Rather, Su discloses a microscopy system utilized to monitor etching parameters, and then utilizing such monitored parameters as feed-forward information to

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facilitate control of a semiconductor manufacturing process. The microscopy techniques as taught in Su are expensive, time consuming, and can be destructive when compared to the optical system of the subject invention.

In view of at least the above, it is readily apparent that neither Eriguchi, *et al.* nor Su, alone or in combination, teach or suggest the subject invention as recited in independent claim 1. Accordingly, this rejection should be withdrawn.

**II. Rejection of Claims 2-6 and 8 under 35 U.S.C. §103(a)**

Claims 2-6 and 8 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Eriguchi, *et al.* and Su, and further in view of Xu, *et al.* (U.S. 6,483,580). Withdrawal of this rejection is respectfully requested for at least the following reasons. Xu, *et al.* discloses a system for measuring film thickness and optical index of films underneath a diffracting structure utilizing a spectroscopic ellipsometer and an associated spectroscopic scatterometer. However, Xu, *et al.* does not disclose, teach, or suggest *directing a single beam of light onto one or more gratings and measuring one or more etching parameters from light reflected from the one or more gratings*, and thus does not make up for the deficiencies of Eriguchi, *et al.* and Su. Therefore, this rejection should be withdrawn.

**III. Rejection of Claims 7 and 9 under 35 U.S.C. §103(a)**

Claims 7 and 9 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Eriguchi, *et al.*, Su, Xu, *et al.*, and further in view of Ko, *et al.* (U.S. 6,117,791). Withdrawal of this rejection is respectfully requested for at least the following reasons. Claims 7 and 9 depend from independent claim 1, and Ko, *et al.* does not make up for the aforementioned deficiencies of Eriguchi, *et al.* and Su. Therefore, the subject rejection should be withdrawn.

**IV. Rejection of Claim 25 under 35 U.S.C. §103(a)**

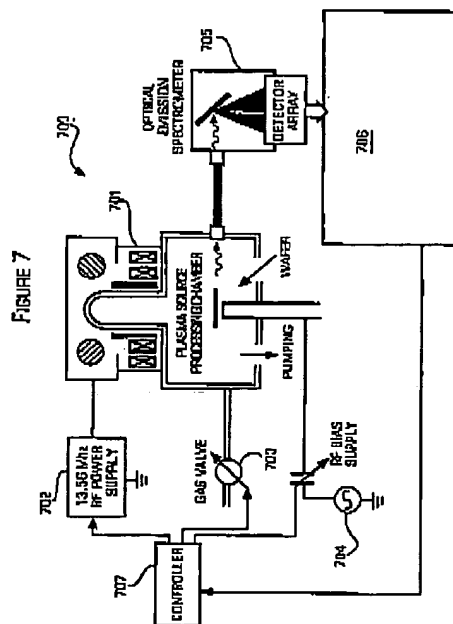
Claim 25 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Jahns (U.S. 5,711,843) in view of Su and further in view of Xu. Reconsideration and allowance of this claim is respectfully requested for at least the following reasons. Neither Jahns, Su, nor Xu teaches or suggests combining elements of the subject claim.

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Absent some teaching or suggestion in the prior art to combine elements, it is insufficient to establish obviousness by claiming that the separate elements of the invention existed in the prior art. *Arkie Lures Inc. v. Gene Larew Tackle Inc.*, 43 USPQ2d 1294, 1297 (Fed. Cir. 1997).

The Examiner has improperly rejected the subject claim by simply stating that separate elements of the claim existed in the prior art. Particularly, the Examiner contends that Jahns discloses a system in Figure 7 that comprises a spectrometer with a detector array for sensing the acceptability of etching in at least one... grid block. Nowhere in such figure or accompanying text is there a disclosure, teaching, or suggestion of a means for sensing acceptability of etching in at least one of the grid blocks. Fig. 7 of Jahns is produced below to illustrate, in particular, a lack of *one or more grid blocks* as claimed.



As can be determined from viewing the above Figure, there is nothing therein that teaches or suggests *scatterometry means for sensing the acceptability of etching in at least one of the ...*

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*grid blocks* as claimed, as there is no teaching or suggestion of a *grid block* anywhere within Jahns. Rather, an entire wafer is delivered to a plasma reactor 701, and is processed utilizing plasma. Rather than teaching *scatterometry means for sensing the acceptability of etching in at least one of the ... grid blocks*, Jahns teaches monitoring process environment properties, such as temperature of plasma, gas flow rate, gas pressure, etc. (See col. 3 lines 38-44). One or more of such sensed environmental properties are relayed to a process condition monitor, which determines whether any of such properties (or a combination of properties) renders the process defective. Utilizing the invention as disclosed in Jahns, an etching process is labeled as defective *based upon parameters within the process chamber*, and not based upon parameters of a wafer being processed. Furthermore, the system of Jahns cannot determine *grid blocks* of a wafer that are defective. Rather, an entire wafer would be deemed defective (as defectiveness is determined based upon a process) even in an instance that only a *grid block* of such wafer was actually defective and could be repaired. Accordingly, Jahns does not disclose, teach, or suggest *sensing the acceptability of etching in at least one of the one or more grid blocks* as recited in the subject claim. Moreover, upon determining that environmental properties are such that etching the wafer is acceptable, etch rates (and various other process parameters) are *estimated* by a classifier based on the environmental properties. Such an arrangement does not facilitate control of etch components particular to a *grid block* of a wafer. Rather, the processes are controlled for an entirety of a wafer.

Su teaches exposing a wafer to create a focus-exposure matrix, and thereafter examining each matrix cell with a conventional CD-SEM scan. Su does not teach or suggest utilizing *scatterometry means for sensing the acceptability of etching in... grid blocks*. As described above, CD-SEM scanning techniques as taught in Su are expensive, time consuming, and can be destructive when compared to the optical system of the subject invention. Xu discloses utilizing scatterometry techniques to measure one or more parameters of a diffracting structure. Xu does not teach or suggest utilizing scatterometry means for *sensing acceptability of etching in a grid block* of a wafer or *partitioning a wafer into one or more grid blocks*.

Accordingly, the Examiner cites Su as disclosing a means for partitioning a wafer into one or more grid blocks. Even if this were correct, however, the Examiner has failed to provide any teaching or suggestion within Jahns or Su to combine such references. Rather, the Examiner has broadly stated that "It would have been obvious to one having ordinary skill in the art, at the

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time of invention, to modify Jahns and Xu in view of Su by including a means for portioning (partitioning) a wafer into one or more grid because allow multiple patterns on the wafer." Yet, the Examiner has not provided any evidence of such rationale within any of the cited references.

Su teaches exposing a wafer to create a focus-exposure matrix, and thereafter examining each matrix cell with a conventional CD-SEM scan. Su does not teach or suggest utilizing *scatterometry means for sensing the acceptability of etching in... grid blocks*. -SEM scanning techniques as taught in Su are expensive, time consuming, and can be destructive when compared to the claimed optical system. Xu discloses utilizing scatterometry techniques to measure one or more parameters of a diffracting structure. Xu does not teach or suggest utilizing scatterometry means for *sensing acceptability of etching in a grid block* of a wafer or *partitioning a wafer into one or more grid blocks*.

As the Examiner has not proffered any teaching, suggestion, or motivation to combine the cited references, applicants' representatives respectfully submit that the subject rejection is improper and should be withdrawn.



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CONCLUSION

The present application is believed to be in condition for allowance in view of the above comments. A prompt action to such end is earnestly solicited.

Should the Examiner believe a telephone interview would be helpful to expedite favorable prosecution, the Examiner is invited to contact applicants' undersigned representative at the telephone number below.

Respectfully submitted,

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